

# Constructing a transport hGIS

## Does infrastructure follow infrastructure?

**Other Conference Item**

**Author(s):**

Fuhrer, Raphaël

**Publication date:**

2017-10

**Permanent link:**

<https://doi.org/10.3929/ethz-b-000206944>

**Rights / license:**

[In Copyright - Non-Commercial Use Permitted](#)

# Preferred citation style for this presentation

---

Raphaël Fuhrer (2017) Constructing a Transport hGIS: Does Infrastructure Follow Infrastructure?, 15<sup>th</sup> T<sup>2</sup>M conference, Lancaster, October 2017.

# Constructing a Transport hGIS: Does Infrastructure follow Infrastructure?

Raphaël Fuhrer

IVT  
ETH  
Zürich

October 2017

 Institut für Verkehrsplanung und Transportsysteme  
Institute for Transport Planning and Systems

**ETH**

Eidgenössische Technische Hochschule Zürich  
Swiss Federal Institute of Technology Zurich

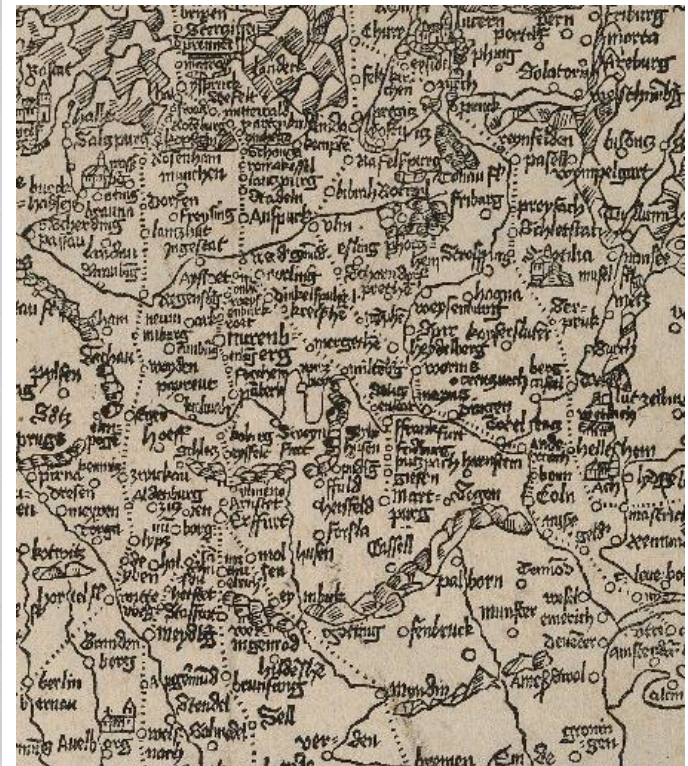
# Overview and motivation: Why constructing a hGIS?

---

- The role of transport infrastructure in the evolvment of spatial economies and finally national states in Western Europe
- Direct and indirect effect in nation building
  - Direct: State presence – enforcing law, alter citizen's life, ...
  - Indirect: Agglomeration effects, urbanisation, productivity
- Accessibility metrics,  $f(\text{generalised travel costs, population})$
  
- Physical transport network in Europe 2000 backwards ... to 1500 (if possible) in certain time intervals
- Information on network characteristics, transport means, related infrastructure (horse relays, inns etc.)
- Population distribution

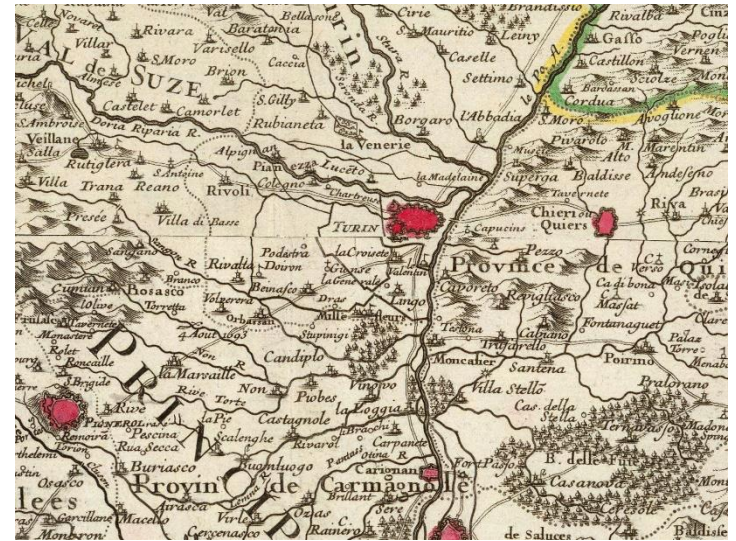
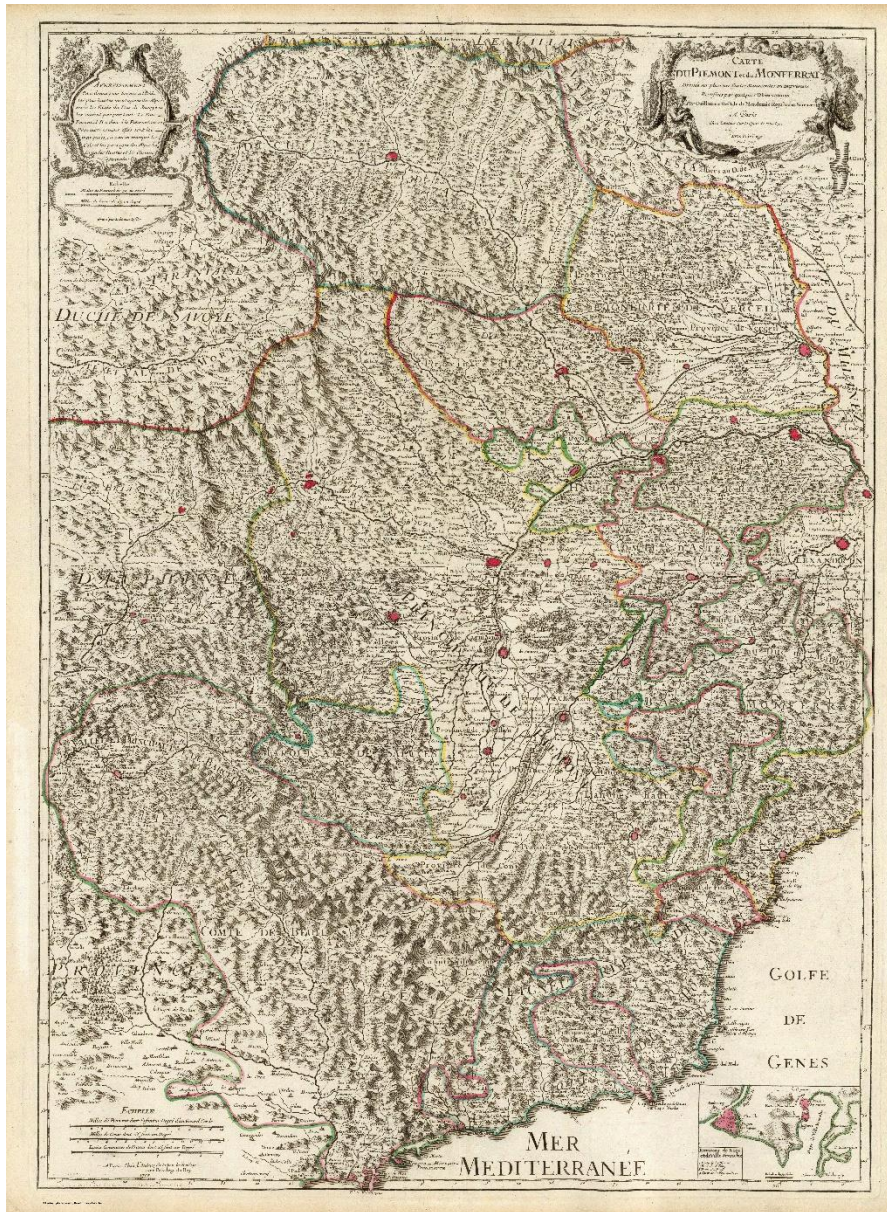


# Materials for constructing a hGIS





# Materials for constructing a hGIS (2)





# Materials for constructing a hGIS (3)



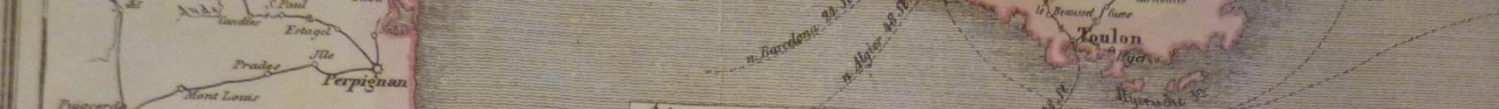


# Materials for constructing a hGIS (4)





# Materials for constructing a hGIS (5)



## Eisenbahnen = Tabelle

mit Berechnung der Ortsentfernungen nach Stunden, der Fahrzeit nach Stunden u. Minuten u. des Fahrpreises der 2<sup>ten</sup> od. mittleren Classe.

von Leipzig				von Breslau				von Köln				von Straßburg				von Düsseldorf				von Wien				von Paris							
Entf. St.	Fahrz. St.	Preis Th.	Pr. Sg.	Entf. St.	Fahrz. St.	Preis Th.	Pr. Sg.	Entf. St.	Fahrz. St.	Preis Th.	Pr. Sg.	Entf. St.	Fahrz. St.	Preis Th.	Pr. Sg.	Entf. St.	Fahrz. St.	Preis Th.	Pr. Sg.	Entf. St.	Fahrz. St.	Preis Th.	Pr. Sg.	Entf. St.	Fahrz. St.	Preis Th.	Pr. Sg.				
18	1	—	—	23	2	45	1	19	2	45	1	18	2	45	1	7	1	—	—	22	2	30	3	31	3	—	—	31	3	—	—
37	5	15	2	15	2	1	—	31	6	—	2	25	7	10	4	22	2	30	1	40	4	45	6	60	6	15	8	60	6	15	8
59	6	30	4	45	5	30	3	55	9	—	4	33	5	7	4	30	4	30	2	50	5	45	7	80	8	—	—	80	8	—	—
75	8	50	5	74	9	55	5	70	12	—	4	33	4	32	3	54	7	10	8	74	7	45	9	100	10	—	—	100	10	—	—
51	5	—	2	71	9	—	5	89	13	30	5	4	—	—	—	56	6	45	8	80	8	—	—	100	10	—	—	100	10	—	—
59	6	20	4	71	9	—	5	61	10	20	4	78	9	—	5	108	10	45	12	80	8	—	—	100	10	—	—	100	10	—	—
52	4	—	2	71	9	—	5	57	9	45	4	4	—	—	—	6	1	—	—	80	8	—	—	100	10	—	—	100	10	—	—
44	5	30	3	71	9	—	5	8	—	50	10	5	—	—	—	4	4	5	2	80	8	—	—	100	10	—	—	100	10	—	—
40	4	10	—	71	9	—	5	9	—	15	—	11	1	30	—	16	3	0	9	80	8	—	—	100	10	—	—	100	10	—	—
26	2	45	1	71	9	—	5	16	2	25	1	26	4	15	1	23	2	12	5	80	8	—	—	100	10	—	—	100	10	—	—
16	1	—	—	71	9	—	5	46	2	45	1	38	7	45	2	15	1	—	—	82	8	15	11	100	10	—	—	100	10	—	—
25	2	45	1	71	9	—	5	15	2	45	2	15	2	45	2	12	1	—	—	82	8	15	11	100	10	—	—	100	10	—	—
30	4	45	3	71	9	—	5	9	1	—	1	5	—	—	—	12	1	20	—	82	8	15	11	100	10	—	—	100	10	—	—
46	6	—	3	71	9	—	5	10	1	30	1	26	5	45	1	28	3	5	2	82	8	15	11	100	10	—	—	100	10	—	—
59	7	30	4	71	9	—	5	7	—	54	4	8	1	15	—	17	1	—	—	82	8	15	11	100	10	—	—	100	10	—	—
49	7	30	3	71	9	—	5	23	3	—	3	17	4	30	1	16	2	—	—	82	8	15	11	100	10	—	—	100	10	—	—
39	4	5	3	71	9	—	5	23	3	—	3	14	2	—	—	12	1	40	—	82	8	15	11	100	10	—	—	100	10	—	—
54	6	3	4	71	9	—	5	37	5	17	4	26	3	30	1	27	3	15	1	82	8	15	11	100	10	—	—	100	10	—	—
66	6	—	5	71	9	—	5	72	8	—	6	—	—	—	—	23	2	20	—	82	8	15	11	100	10	—	—	100	10	—	—
82	10	40	6	71	9	—	5	16	2	—	1	15	2	10	1	15	2	10	1	82	8	15	11	100	10	—	—	100	10	—	—
7	—	45	—	71	9	—	5	40	4	10	1	40	3	40	2	40	3	40	2	82	8	15	11	100	10	—	—	100	10	—	—
56	4	50	3	71	9	—	5	62	7	40	6	97	13	36	9	40	3	40	2	82	8	15	11	100	10	—	—	100	10	—	—
24	2	40	1	71	9	—	5	62	7	40	6	97	13	36	9	40	3	40	2	82	8	15	11	100	10	—	—	100	10	—	—
95	12	40	7	71	9	—	5	97	13	36	9	16	2	—	—	16	2	—	—	82	8	15	11	100	10	—	—	100	10	—	—
59	6	—	3	71	9	—	5	16	2	—	—	16	2	—	—	16	2	—	—	82	8	15	11	100	10	—	—	100	10	—	—
76	8	30	5	71	9	—	5	8	1	11	1	4	—	—	—	4	—	—	—	82	8	15	11	100	10	—	—	100	10	—	—
75	8	40	5	71	9	—	5	17	2	36	2	17	2	36	2	32	3	45	2	82	8	15	11	100	10	—	—	100	10	—	—
94	11	25	6	71	9	—	5	16	2	40	2	16	2	40	2	86	8	—	5	82	8	15	11	100	10	—	—	100	10	—	—
11	1	5	—	71	9	—	5	36	5	6	3	22	2	50	3	23	2	45	9	82	8	15	11	100	10	—	—	100	10	—	—
45	6	10	3	71	9	—	5	5	—	—	—	9	1	15	1	26	4	—	—	82	8	15	11	100	10	—	—	100	10	—	—
10	—	58	7	71	9	—	5	12	1	48	1	26	2	50	3	26	2	50	3	82	8	15	11	100	10	—	—	100	10	—	—

**Erläuterungen:**

In den deutschen Bundesstaaten in allen zu Oesterreich u. Preussen gehörigen nicht deutschen Ländern in Dänemark u. Polen bezeichnen die Zahlen in den Straßen die gegen- seitigen Entfernungen der beiden zunächst liegenden Orte in deutschen Meilen u. jeder neben einer Zahl sich befindliche Punkt eine  $\frac{1}{4}$  Meile. — 2 3/4 Meilen.

Auf eine Post werden 2 Meilen oder 4 Stunden gerechnet.

Eine Ausnahme bildet das Königreich Sachsen, wo zwar auch deutsche Meilen angezeichnet sind, die Meile jedoch in 5 Theile getheilt wird u. jeder neben einer Zahl sich be- findliche Punkt eine  $\frac{1}{5}$  Meile bezeichnet — 2 2/5 Meilen.

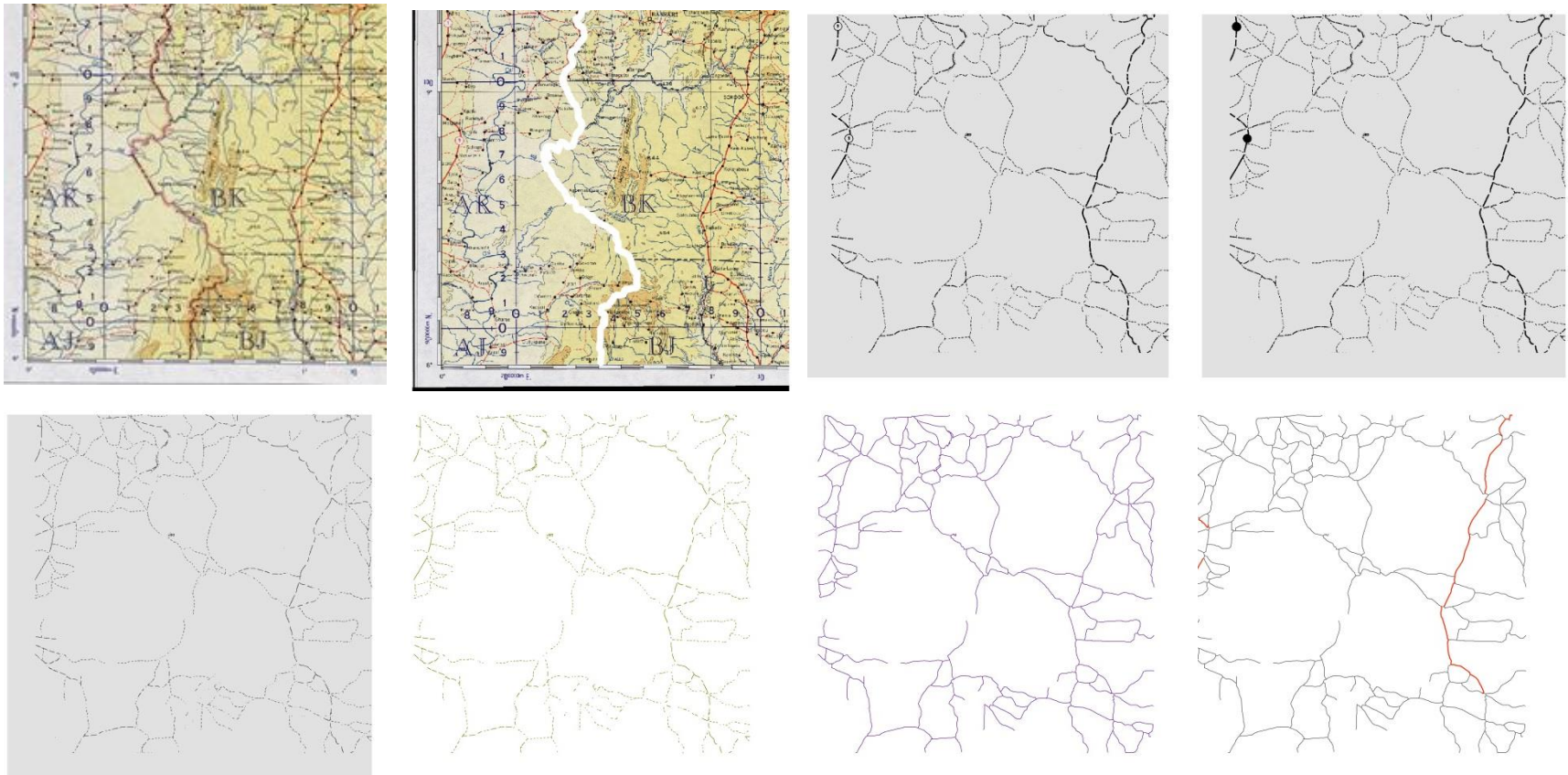
In der Schweiz sind die Entfernungen in Schweizer Meilen angegeben. Eine Schweizer Meile umfasst 2 Schweizer Stunden oder  $\frac{1}{4}$  deut. Meilen.

In den Niederlanden sind es holländ. Meilen. Eine holländ. Meile ist  $\frac{1}{3}$  einer deutschen Meile.

In Frankreich sind Posten einge- zeichnet. Jede Post besteht aus zwei Li- aus oder Postleuten, welche  $\frac{1}{2}$  eines Myriameters betragen. (282,600 Liniens)

In Belgien wird nach Lieres ge- rechnet und es gehen durch gleich den französischen 2 auf eine Post.

# Semi-automated digitalisation algorithm



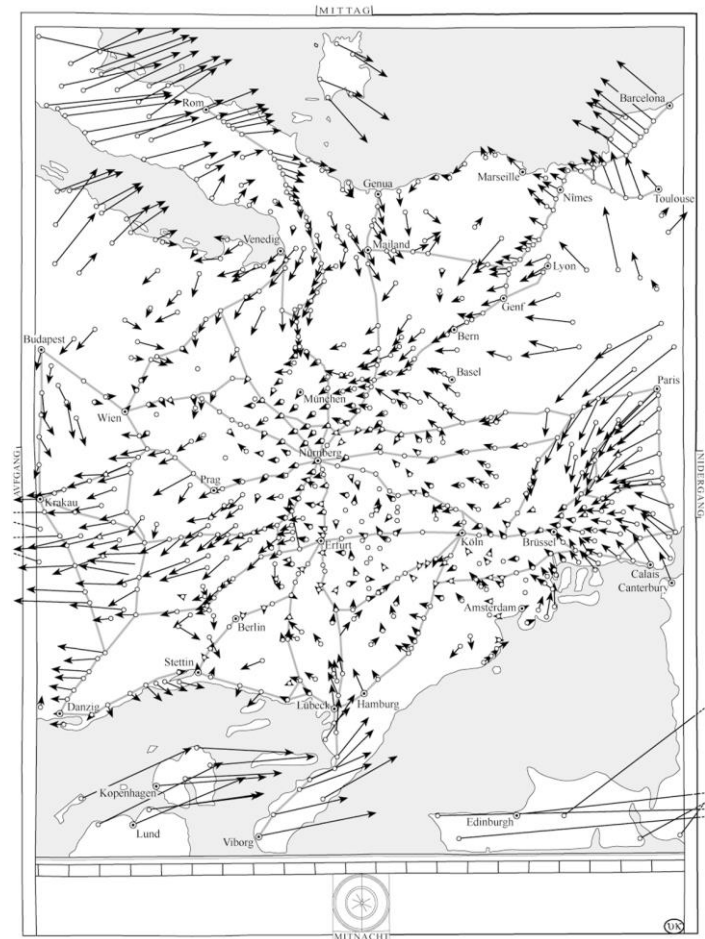
Original – Pre-Treatment – Pixel extraction – Removing circles –  
Skeletonisation – Vectorisation – Line snapping – Classification



# Automated processing of monochrome maps: Problems

- A black line can be a road, river, coast, letter etc.
- Projection unclear
- Spatial accuracy, precision
- Uniformity: mostly single maps
- Missing meta data
- Mapping style: poor information

➤ Automation is impossible,  
and manual work is needed.

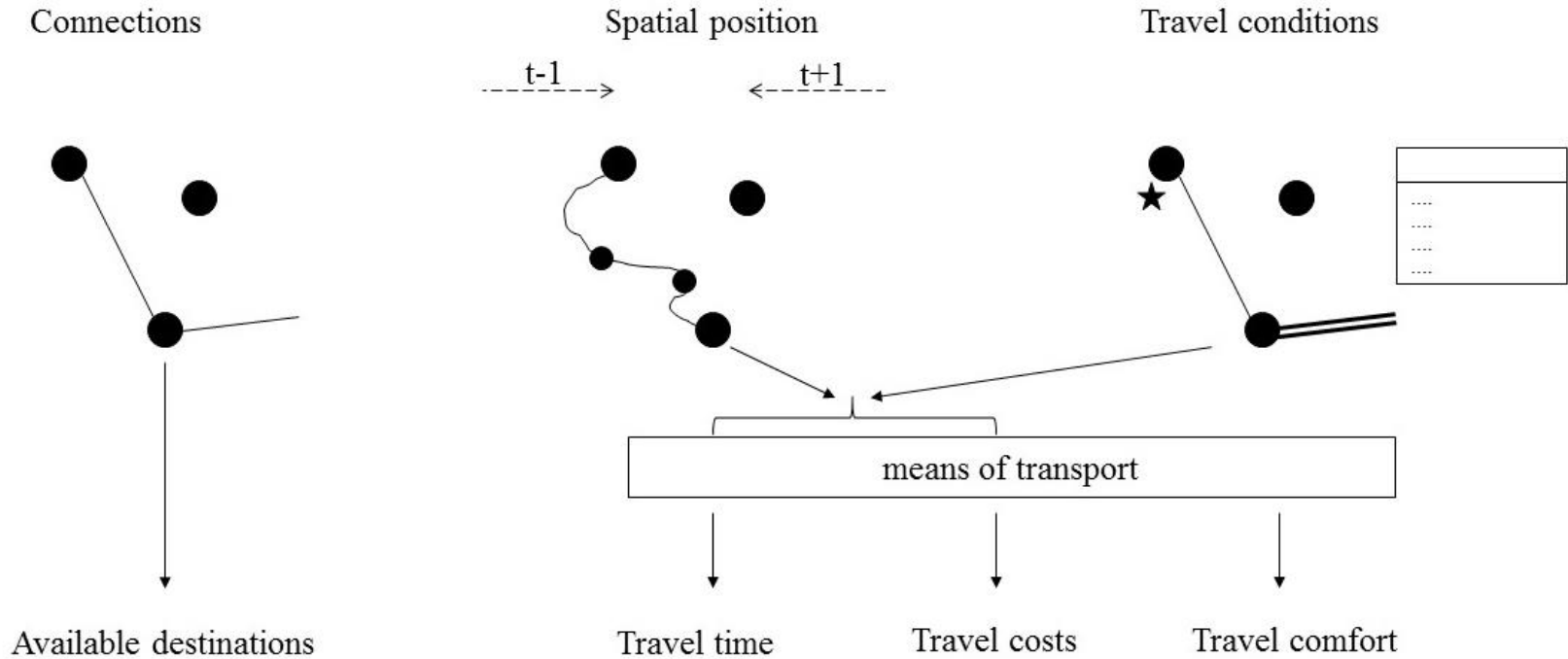


# Example: Reconstructing 1850 Switzerland travel times



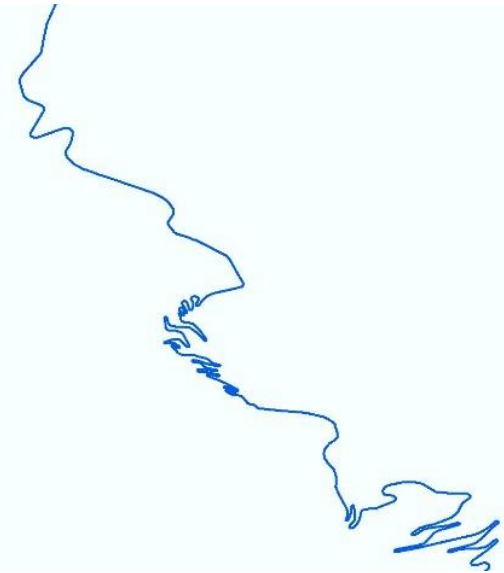
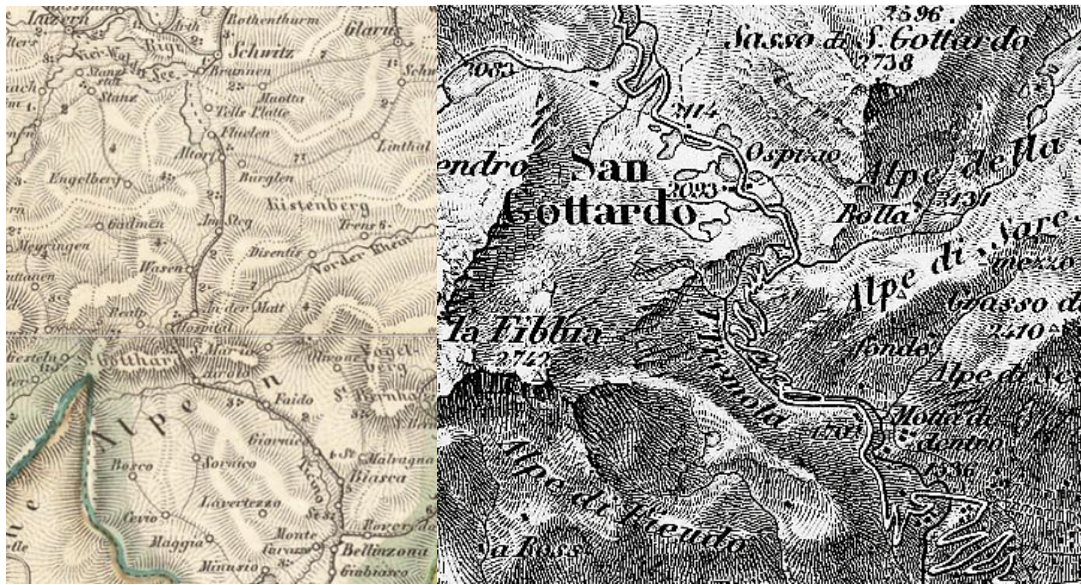


# Structured combination of historical materials



# Reconstructing the exact spatial position of a post road

---





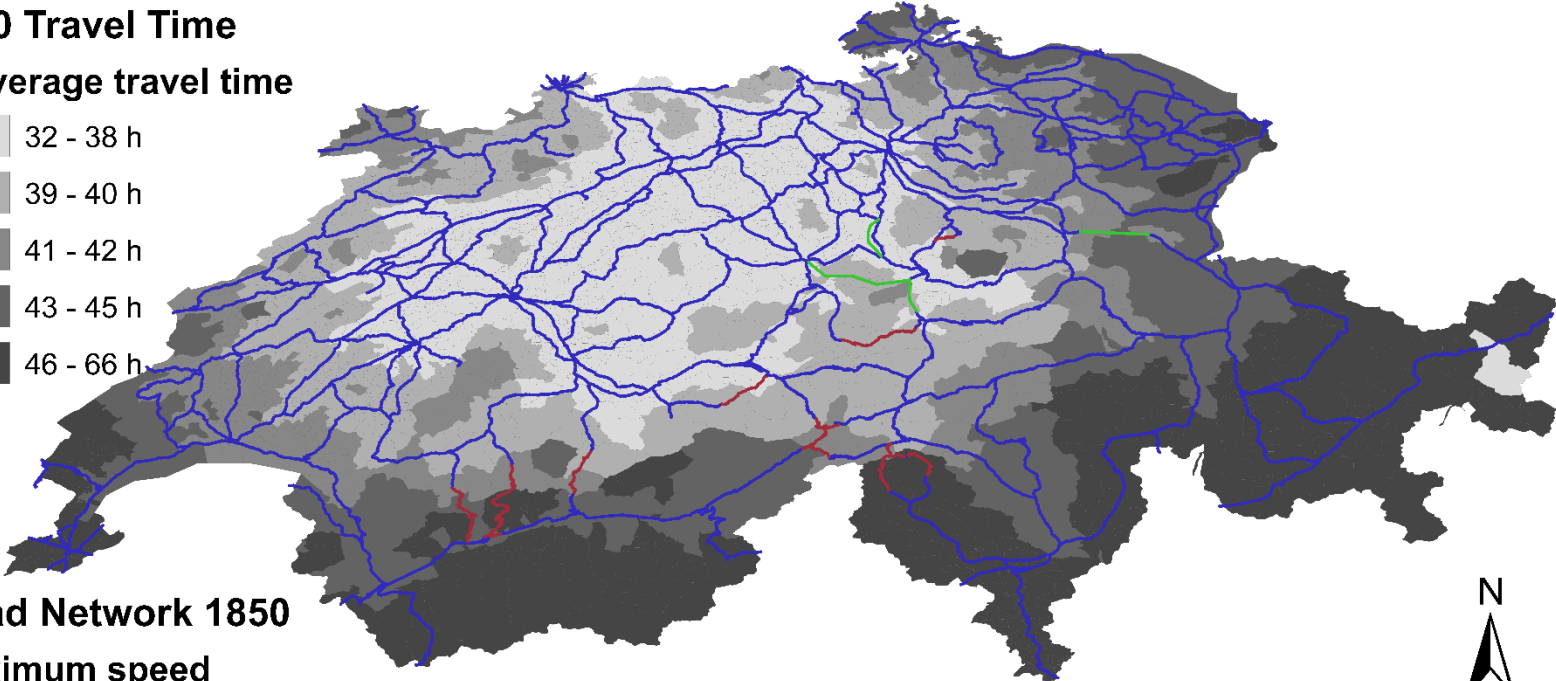
# Calculated average travel times

## 1850 Travel Time in average travel time

- 32 - 38 h
- 39 - 40 h
- 41 - 42 h
- 43 - 45 h
- 46 - 66 h

## Road Network 1850 Maximum speed

- 3 km/h
- 10 km/h
- 12 km/h



0 15 30 60 90 120 Kilometers





# Infrastructure follows infrastructure

---

Out of 100% of the 1850 stagecoach road network length (excluding ship routes), which were country roads built until 1850 with horse-related infrastructure,

- roughly 1% became current motorways
- roughly 4% became current hiking trails or alpine paths (“Alpweg”), which are service paths to alpine stables; this transformation mostly occurred with bridle paths over mountain passes
- roughly 89% became current main roads, mostly “Kantonsstrassen” (state/ country roads)
- roughly 6% became secondary or tertiary roads, mostly in urban areas, where former main roads were converted into “city-friendlier” roads